GLASS SPONGES ▪ HAENYEO DIVERS ▪ CLOUDS ON VENUS ▪ LANGUAGE DECODER

FOR CURIOUS YOUNG MINDS 8 TO 14

# Brainspace

A SMART & INTERACTIVE MAGAZINE

DECEMBER 2025/JANUARY 2026

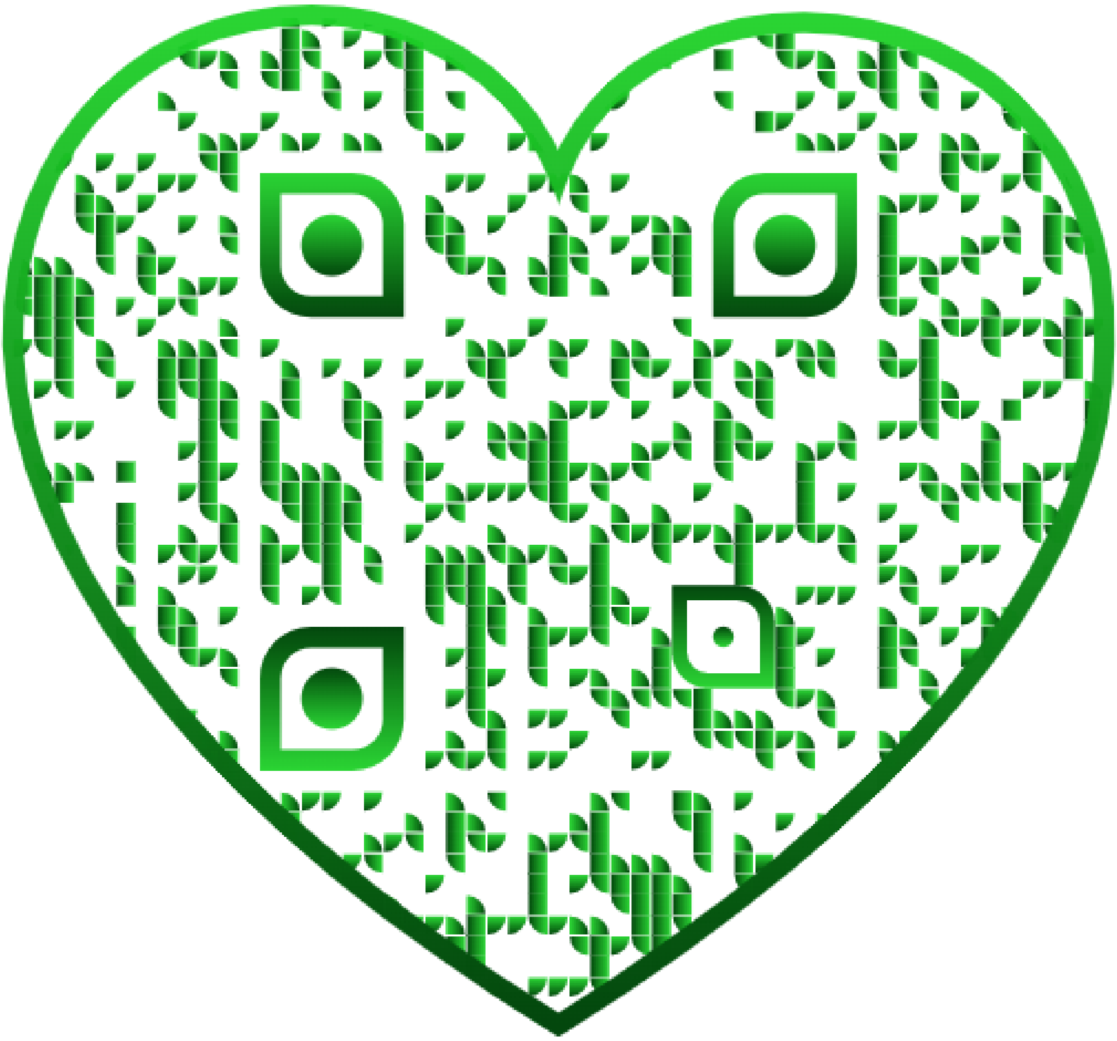
LAUNCH ZAPPAR
TO WATCH

## THE ART AND HISTORY OF tattooing

## 8 COOL CRAFTS, ACTIVITIES & EXPERIMENTS

## THE WORLD'S OLDEST TORTOISE TURNS 193

## 8 WAYS THE WORLD CELEBRATES THE NEW YEAR



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why is it raining FISH & FROGS?
DNA EXTRACT IT FROM A BANANA!
SEE ONE-OF-A-KIND CREATURES
UP IN THE TREES ARE NEW LIFE DISCOVERIES
MAKE SOME NOISE
EXPERIMENT WITH SOUND AND MOTION
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Naming a Shark
Learn the meaning in a shark's name
Love math
Play a calculating game with dice
Lost City
Discover Roman history in Pompeii
The science of spit
Find out why saliva is super!
Girl Power
Why clownfish and other animals prefer female leaders

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MISSION
***Brainspace*** magazine produces intelligent and engaging articles for students ages 8 to 14 in a format that bridges the gap between print and digital technology to expand literacy and promote optimal learning.

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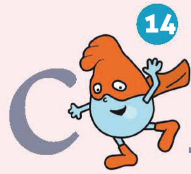

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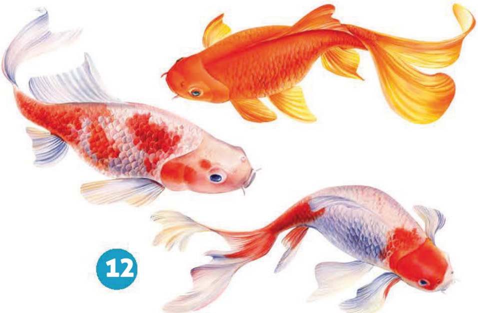


LAUNCH ZAPPAR TO WATCH

## WHAT ARE GLASS SPONGES?

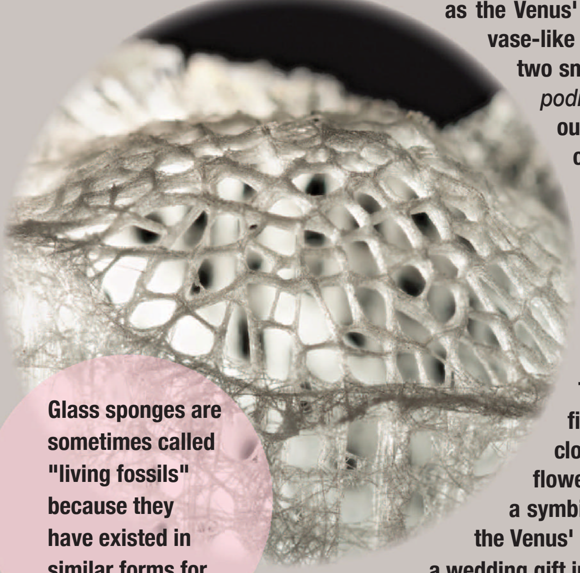
Delicate and beautiful glass sponges, also known as *Hexactinellida*, live deep beneath the ocean's surface. Unlike the soft, squishy sponges used for cleaning, these sponges have skeletons made of silica—the same material we use to make glass. Their skeletons are built from tiny, needle-like structures called spicules that fuse into intricate glass structures that can last long after the sponge has died.

Small glass sponge reefs and gardens have been discovered in deep cold waters around Alaska, Antarctica, New Zealand and in the Mediterranean Sea.

# DISCOVERING GLASS SPONGES

## NATURE'S UNDERWATER SCULPTURES

**BY COLLETTE YVONNE**



Some species, such as *Euplectella aspergillum* (also known as the Venus' flower basket), grow into beautiful, vase-like structures. This sponge often houses two small, shrimp-like crustaceans (*Stenopodidea*), a male and a female, who live out their lives inside the sponge. The crustacean pair enter the sponge when they are small and eventually become trapped as they grow. They live safely inside their glass home, protected from predators. The couple keeps their glass basket clean, and in return, they snack on bits of food that the sponge doesn't need. Their crustacean babies escape to find a new basket of their own. This close relationship between glass Venus' flower baskets and crustaceans is called a symbiotic relationship. It is so unique that the Venus' flower basket is sometimes given as a wedding gift in Japan, symbolizing eternal love.

Glass sponges are sometimes called "living fossils" because they have existed in similar forms for millions of years.

## Did You Know?

**Some individual glass sponges are thought to live over 10,000 years, making them the longest-lived animals known.**

## DEEP DARK HABITATS

Glass sponges are typically found at depths of 200 to 1,000 metres (656 to 3,281 feet) below the ocean's surface, where sunlight doesn't reach. They often grow on hard surfaces such as rocks. These sponges feed by filtering tiny particles, such as bacteria and plankton, from the water around them. Their unique skeletons not only support their bodies but also help them capture food and protect themselves from predators.

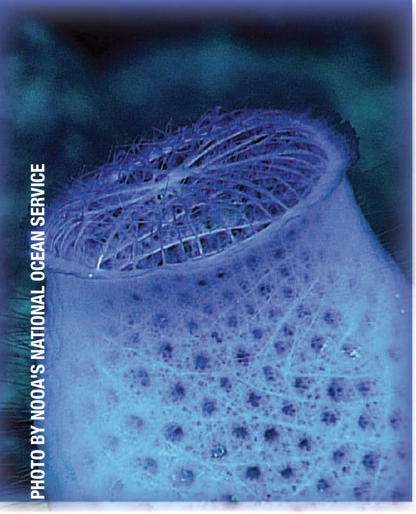


PHOTO BY NOAA'S NATIONAL OCEAN SERVICE

PHOTO BY ADAM TAYLOR

## GLASS SPONGE REEFS: UNDERWATER CITIES

In some parts of the world, glass sponges form underwater structures known as glass sponge reefs. Glass sponge reefs are incredibly rare. Scientists believed these reefs went extinct over 40 million years ago! In 1987, massive glass sponge reefs were found in the northern Pacific Ocean, off the coast of British Columbia (B.C.), Canada. Glass sponge reefs are made up of thousands of interconnected sponges that create a home for various sea creatures such as rockfish, crabs, worms, sea stars and more. The sponge skeletons have many crevices, folds, chimneys (openings), and cavities that animals use to hide from predators.

## REEF PROTECTION

The massive, ancient B.C. glass sponge reefs are so important for biodiversity (the variety of ocean life) that they have been made into several marine protected areas along B.C.'s Pacific coastline to ensure they are preserved.

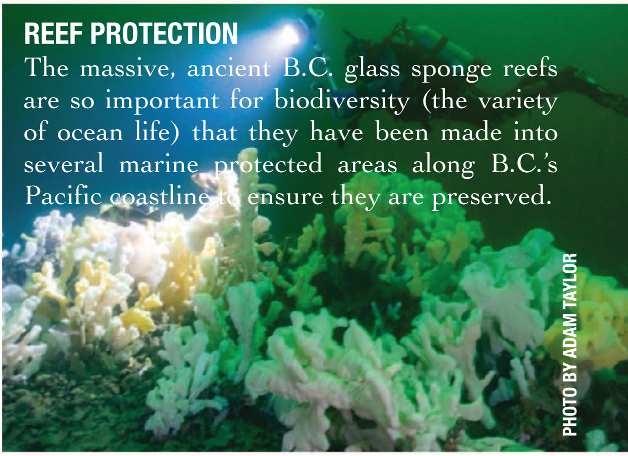


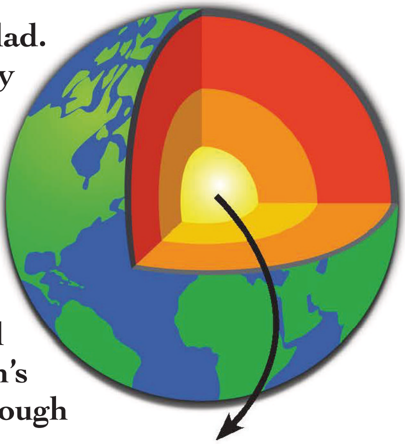
PHOTO BY ADAM TAYLOR

# IRON

## The Element That Changed the World

BY COLLETTE YVONNE

Iron-willed. Iron-fisted. Iron-clad. When people use the word iron, they are often talking about strength and toughness. That's because the element iron is associated with things that are strong. This mighty metal is found all over the world – and deep down at the centre of our planet, where an iron-nickel layer swirls around, driving Earth's magnetic field! It even flows through your blood to help you breathe.



26
**Fe**
iron
55.845

### What is iron?

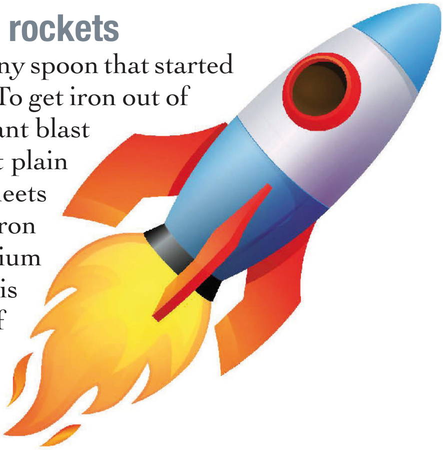
Iron has the symbol Fe on the periodic table. It's a shiny, silvery metal that bends and shapes easily when heated. But mix it with other elements such as carbon or nickel, and it becomes strong enough to build airplanes, bullet trains and towers that scrape the sky.

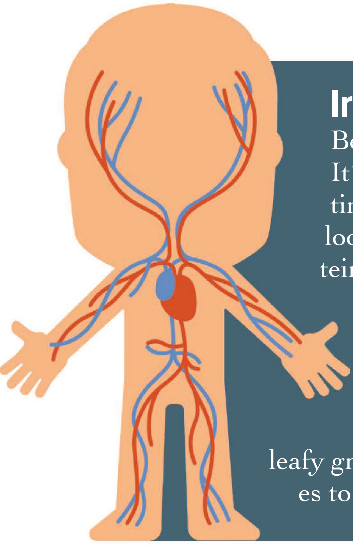
## The Iron Age

**Archaeologists continue to find ancient forges all over the world where, long ago, people hammered heated iron into tools. Early humans used iron that fell from the sky in meteorites. Around 1200 BCE, humans learned how to heat certain kinds of rocks, called iron ores, to get the metal out. That discovery kicked off the Iron Age. Suddenly, people could make tough ploughs for farming, sharper weapons for battle and better tools for everyday life. Iron changed history forever.**

## Iron to steel to spoons to space rockets

Imagine scooping up ice cream with a shiny spoon that started out as a rock buried deep in the ground. To get iron out of a rock, miners crush it and heat it in a giant blast furnace in a process called smelting. But plain iron has a problem—it rusts when it meets water and air. To fix this, people turn iron into steel. Adding metals such as chromium and nickel makes stainless steel that is super tough and shiny. That's the stuff used to make everything from sewing needles to space rockets.





## Iron in your body

Believe it or not, you've got iron inside you right now! It's in your blood, and without enough of it, you'd feel tired, weak, and out of breath. Iron is the reason blood looks red. It's tucked inside hemoglobin, a special protein in red blood cells. Think of hemoglobin as a fleet of tiny delivery trucks—each red blood cell carries about 270 million of them. They pick up oxygen in your lungs and carry it off to every cell in your body. To keep those trucks running, you need to eat iron-rich foods such as red meat, beans, and leafy greens, along with vitamin C-rich foods such as oranges to help your body absorb the iron.

# Bzzzz... Brrrr!

## How Insects Survive the Winter

**By Holly Bennett**

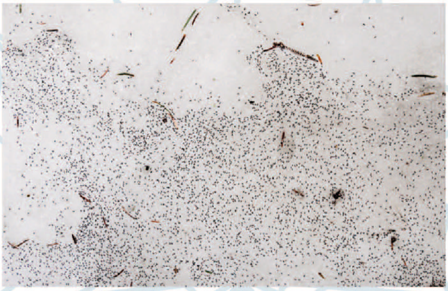
They're tiny. They're cold-blooded. Some are very fragile. Yet every spring, the insects are back. How do they make it through the deep freeze of winter? They manage it in an amazing variety of ways. Some fly south. Some hibernate. Some even produce their own anti-freeze!

### Survival = Reproducing

Insects have short lifespans, and, for some, personally surviving the winter is not possible. What's important is that the next generation of insects survives. So the adult cricket, for example, will die as winter approaches – but as long as the eggs it lays stay alive, it's a win.

### Winter, Shminter

Snow fleas (also known as springtails) are active through the winter, munching their way through decaying vegetable matter under the forest leaf litter. But on warmer winter days, and especially as things begin to thaw in very early spring, they come out to play. Watch for a mass of tiny black bugs jumping around on the snow – one of the earliest signs of spring!

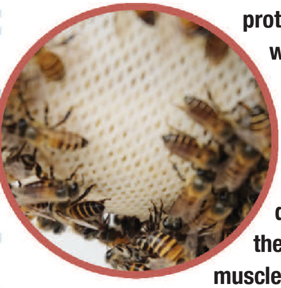


## Follow the Sun

Monarch butterflies and dragonflies are examples of insects that survive by heading south to avoid freezing temperatures.

Monarchs are famous migrators, travelling up to 4,828 km (3,000 miles) to Mexico or California for the winter, and returning north in the spring. Mind you, it takes them three or four generations to make the round-trip journey!

## Hunker Down or Cuddle Up



Deep in the ground, at the bottom of a pond, or tucked inside a plant stem, insects seek warmer, protected places to shelter from the weather. Some, such as ladybugs, huddle together for extra warmth.

Honeybees ball tightly together in their hive, facing in. The queen is in the centre and goes into diapause until spring. The bees on the outside ring "shiver" their flight muscles to generate warmth. Those on the inside feed on the honey they've stored all summer and tend to any eggs or larvae. Then they change places so the outer bees can eat and warm up.

If you put your ear against a beehive in the winter, you'll hear the hum they make, almost like a tiny fan vibrating!

## A Long Winter's Nap

Most insects go into a form of dormancy called diapause, similar to a bear's hibernation. Their body functions slow down so they stop eating and growing. (Some become quiescent, a lighter dormancy that allows them to become briefly active during warm winter days.) But that's only half the battle – they still need to prevent damage from the intense cold.

## Supercool Insects

Probably the most amazing insect survival trick is to produce antifreeze. There are two ways this can work:

1) Freeze-intolerant insects produce a special kind of alcohol that prevents them from freezing. They become "supercooled," meaning the liquid in their bodies drops below 0°C (32°F) but does not freeze.

A superstar of the supercooled insects is the beetle *Pytho deplanatus*. It can remain unfrozen at -54°C (-65°F)!

2) Freeze-tolerant insects can actually freeze solid and survive. How? The antifreeze they produce controls where the ice crystals form within their bodies, keeping ice out of their vital cells and organs.

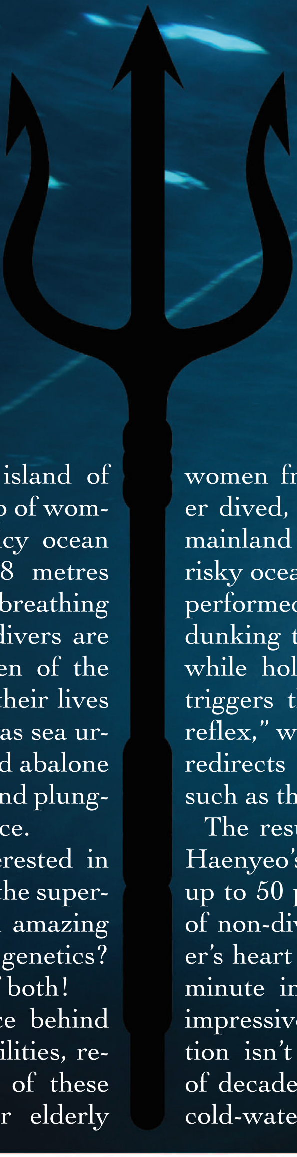
The arctic woolly bear moth caterpillar spends most of its life as a fuzzy popsicle, surviving temperatures as low as -70°C (-94°F)! When summer comes, it thaws and gets on with life.

BY OSKAR LISET PRYDS HANSEN

# The Haenyeo

## South Korea's women of the sea

BY BEN MAYCOCK



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On the South Korean island of Jeju, a remarkable group of women routinely dive into icy ocean waters to depths of 18 metres (59 feet) without any breathing equipment. These free divers are the Haenyeo, or "women of the sea," and they've spent their lives harvesting seafood such as sea urchins and sea snails called abalone by holding their breath and plunging deep below the surface.

Researchers were interested in what gave these women the superpowers to perform such amazing feats. Was it training or genetics? It turns out to be a bit of both!

To uncover the science behind the Haenyeo's diving abilities, researchers compared 30 of these veteran divers to other elderly women from Jeju who had never dived, as well as women from mainland South Korea. Instead of risky ocean dives, the participants performed "simulated dives" by dunking their faces in cold water while holding their breath. This triggers the body's natural "dive reflex," which slows the heart and redirects blood to vital organs, such as the brain.

The results were dramatic. The Haenyeo's heart rates dropped up to 50 percent more than those of non-divers. In one case, a diver's heart rate fell by 40 beats per minute in just 15 seconds. This impressive physiological adaptation isn't genetic—it's the result of decades of breath-holding and cold-water immersion. In other

A PHOTOGRAPH TAKEN ON JEJU ISLAND, SOUTH KOREA IN 2014 IN THE EXHIBIT "(BASED ON A TRUE STORY) AND OTHER PHOTOGRAPHIC TALES - PHOTOGRAPHS BY DAVID ALAN HARVEY" AT THE PAUL PALETTI GALLERY.

**The Haenyeo start diving when they are young girls and continue for decades into old age. The current average age for the Haenyeo is 70 years old!**

words, training works.

Scientists also analyzed saliva samples to see if there were genetic differences between the groups. They discovered that all the Jeju Island women, whether they dove or not, shared two rare gene variants not commonly found in mainlanders.

One of the rare genes appears to improve tolerance to cold, helping explain how the Haenyeo dive year-round, even in snow and 10°C (50°F) water. The second is linked to lower blood pressure, a major advantage when diving since high blood pressure can be dangerous under water.

While the Haenyeo tradition is fading, their legacy may continue in science and medicine.

Researchers believe these findings could one day help in treating diseases related to blood pressure, such as hypertension and stroke.

Turns out, these grandmothers of the sea may have superpowers, not just from training, but written in their genes.

Humans (*Homo sapiens*) are among the longest-lived animals, with lifespans of 80 years being common. But we are far from holding the record for longevity, by a long shot. Some species survive for hundreds of years! What's their secret? Let's see what the science says!

# Nature's Oldest Living LEGENDS

BY COLLETTE YVONNE

## Clams with 500 rings

Ocean quahogs (*Arctica islandica*) are among the longest-lived animals on Earth. These clams, found in the cold North Atlantic, can survive for more than 500 years! Ocean quahogs are bivalves, meaning they have two hard shells that are hinged together. Each year, they add a growth ring to their shells, like a tree adds rings to its trunk. Scientists study these rings to learn about past ocean climates. Ocean quahogs like to take it easy: they spend their lives buried in sand or mud, hiding from predators and filtering water to find food, including plankton. Their slow growth and low energy needs help them live for centuries.

LAUNCH ZAPPAR TO WATCH

## Wise old koi

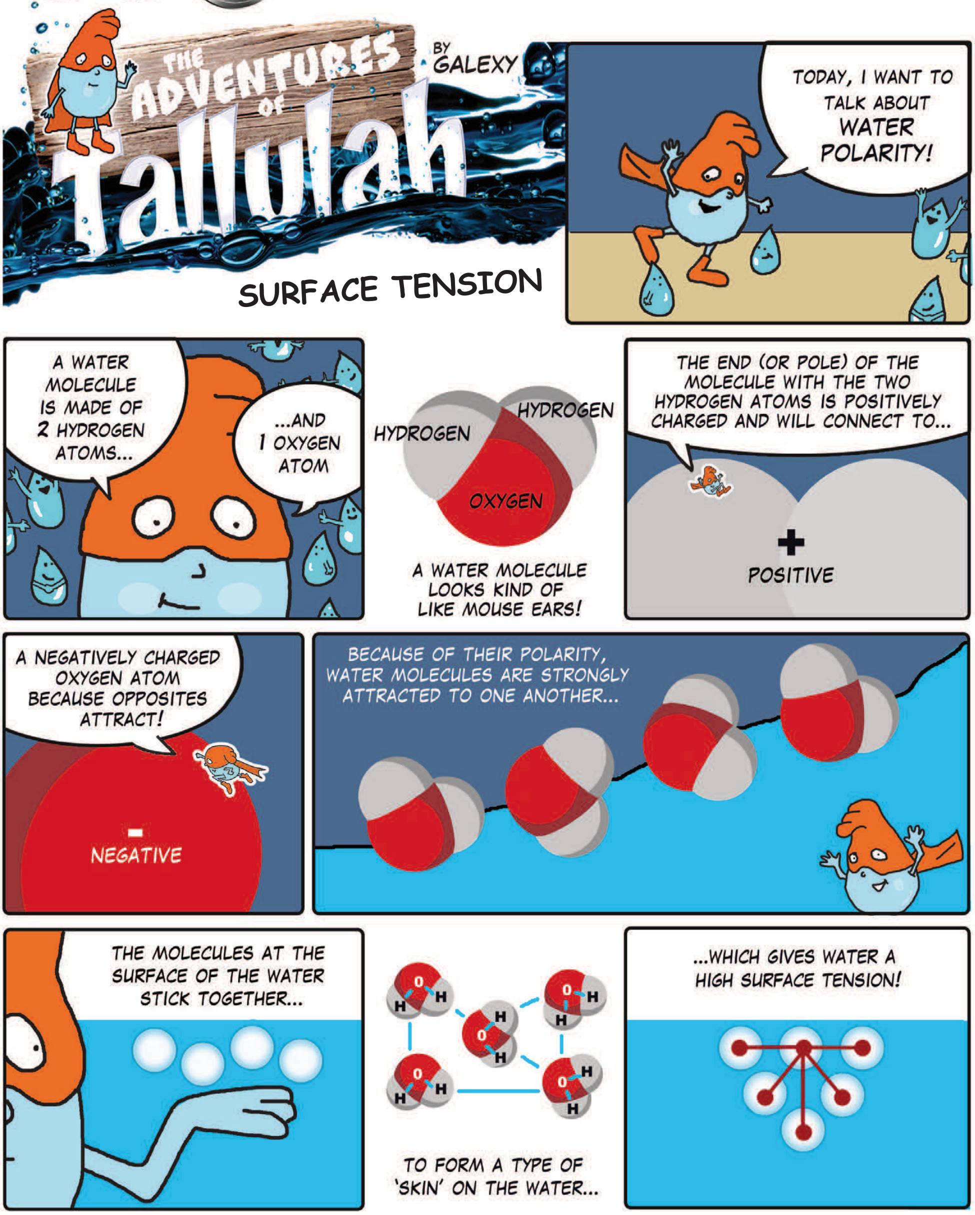
Koi (*Cyprinus rubrofuscus*) are intelligent and colourful fish that, with excellent care, can live far longer than most people might expect. In Japan, where careful fish-keeping is a long-standing tradition, koi can grow very large, reaching over 1 metre (3.2 ft) in length, and often live for decades. The most famous koi, named Hanako, lived an incredible 226 years! In the wild, once koi reach adult size, they are better able to escape predators. In captivity, they can be protected from predators altogether. With clean water, proper food, and space to swim, koi can thrive for decades, sometimes even outliving their owners.

## Slow and steady tortoises win the race

Jonathan, a Seychelles giant tortoise (*Aldabrachelys gigantea hololissa*) who lives on the island of Saint Helena, will be 193 on his "official" birthday in December 2025, making him the world's oldest known living land animal. He has a team of caregivers who make sure he gets a healthy diet of fruits and vegetables. Many species of tortoises live more than 100 years. Tortoises move slowly, which reduces wear and tear. Their pokey metabolism means their cells last longer, so they age more gradually. They can also pull their heads, limbs and tails inside their hard shells, to protect themselves from predators.

## Deep, cold and really old sharks

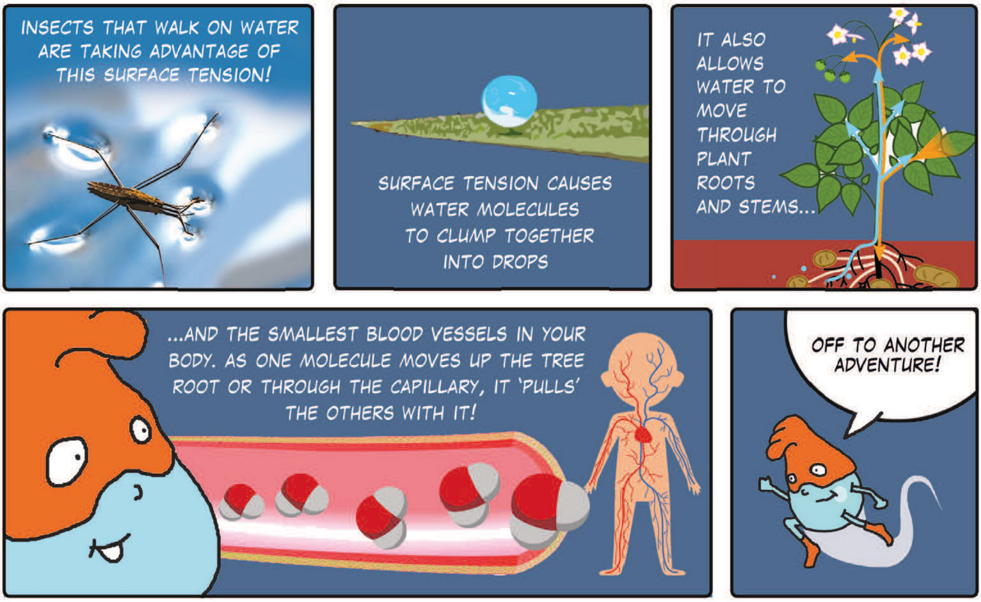
**Greenland sharks (*Somniosus microcephalus*) are the longest-living vertebrates on Earth. They can survive for more than 250 years, and some may reach 500 years old! These sharks swim in the icy waters of the Arctic and North Atlantic Oceans, often at depths of over 2,000 m (6,565 ft). Scientists believe that their impressive lifespan is due to the cold environment and their sluggish movements. But there's more to the story: a 2022 study from the University of Manchester shows that the Greenland shark also has an unusually slow rate of metabolism (the way their bodies turn food into energy). A low metabolic rate means less cellular wear and tear over time, which reduces the damage that leads to aging.**


The Adventures of Tallulah
By Galexy
SURFACE TENSION
TODAY, I WANT TO TALK ABOUT WATER POLARITY!
A WATER MOLECULE IS MADE OF 2 HYDROGEN ATOMS...
...AND 1 OXYGEN ATOM
HYDROGEN
HYDROGEN
OXYGEN
A WATER MOLECULE LOOKS KIND OF LIKE MOUSE EARS!
THE END (OR POLE) OF THE MOLECULE WITH THE TWO HYDROGEN ATOMS IS POSITIVELY CHARGED AND WILL CONNECT TO...
+
POSITIVE
A NEGATIVELY CHARGED OXYGEN ATOM BECAUSE OPPOSITES ATTRACT!
-
NEGATIVE
BECAUSE OF THEIR POLARITY, WATER MOLECULES ARE STRONGLY ATTRACTED TO ONE ANOTHER...
THE MOLECULES AT THE SURFACE OF THE WATER STICK TOGETHER...
O H H
O H H
O H H
O H H
O H H
TO FORM A TYPE OF 'SKIN' ON THE WATER...
...WHICH GIVES WATER A HIGH SURFACE TENSION!

## TRY THIS

### Surface Tension Demonstration

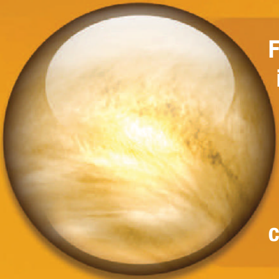
**You will need:**
a bowl, a cup of water, lots of black pepper, a tiny bowl of dish soap


INSECTS THAT WALK ON WATER ARE TAKING ADVANTAGE OF THIS SURFACE TENSION!
SURFACE TENSION CAUSES WATER MOLECULES TO CLUMP TOGETHER INTO DROPS
IT ALSO ALLOWS WATER TO MOVE THROUGH PLANT ROOTS AND STEMS...
...AND THE SMALLEST BLOOD VESSELS IN YOUR BODY. AS ONE MOLECULE MOVES UP THE TREE ROOT OR THROUGH THE CAPILLARY, IT 'PULLS' THE OTHERS WITH IT!
OFF TO ANOTHER ADVENTURE!

1. Fill the glass bowl with water.
2. Cover the surface of the water with black pepper.
3. Dip the tip of your finger in dish soap.
4. Dip the tip of your finger in the water. Observe.

# CLOUDY with a chance of BACTERIA

by William Saunders



**For a long time, scientists thought life on the planet Venus was impossible. Venus reaches 460°C (860°F), its atmospheric pressure is 90 times higher than Earth's and the clouds rain acid, instead of water.**

**Venus' atmosphere doesn't even have any oxygen to breathe. But way up in the clouds, something different might be happening. Astronomers think there might be signs of microscopic life in the clouds on Venus.**

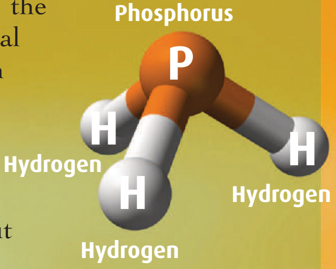
Astronomers study clouds on Venus by looking at the light coming from them. Different chemicals in the clouds produce different colours of light, which is called a spectrum. Astronomy professor Jane Greaves is an expert at analyzing a spectrum to determine the chemicals that created it. She uses telescopes to observe the clouds on Venus and computers to help her make sense of each spectrum. In 2017, she noticed a chemical gas in the clouds that she didn't expect. She enlisted the help of other astronomers and they used massive telescopes to confirm the gas was really there. Then they announced to the world they had discovered a tiny amount of phosphine gas in the clouds on Venus.

## Why does finding phosphine on Venus matter?

**All phosphine gas on Earth is produced by bacteria. That means bacteria could be living in the clouds on Venus and producing phosphine there too!**

## What is phosphine gas?

Phosphine gas is a type of chemical made of the elements phosphorus and hydrogen. Its chemical symbol is $PH_3$, meaning it has 3 hydrogen atoms for every phosphorus atom. On Earth, phosphine is incredibly rare. It can only be produced by a type of bacteria that mostly lives underground. These bacteria survive without oxygen. Humans can't breathe on Venus, but these bacteria don't even need to breathe!

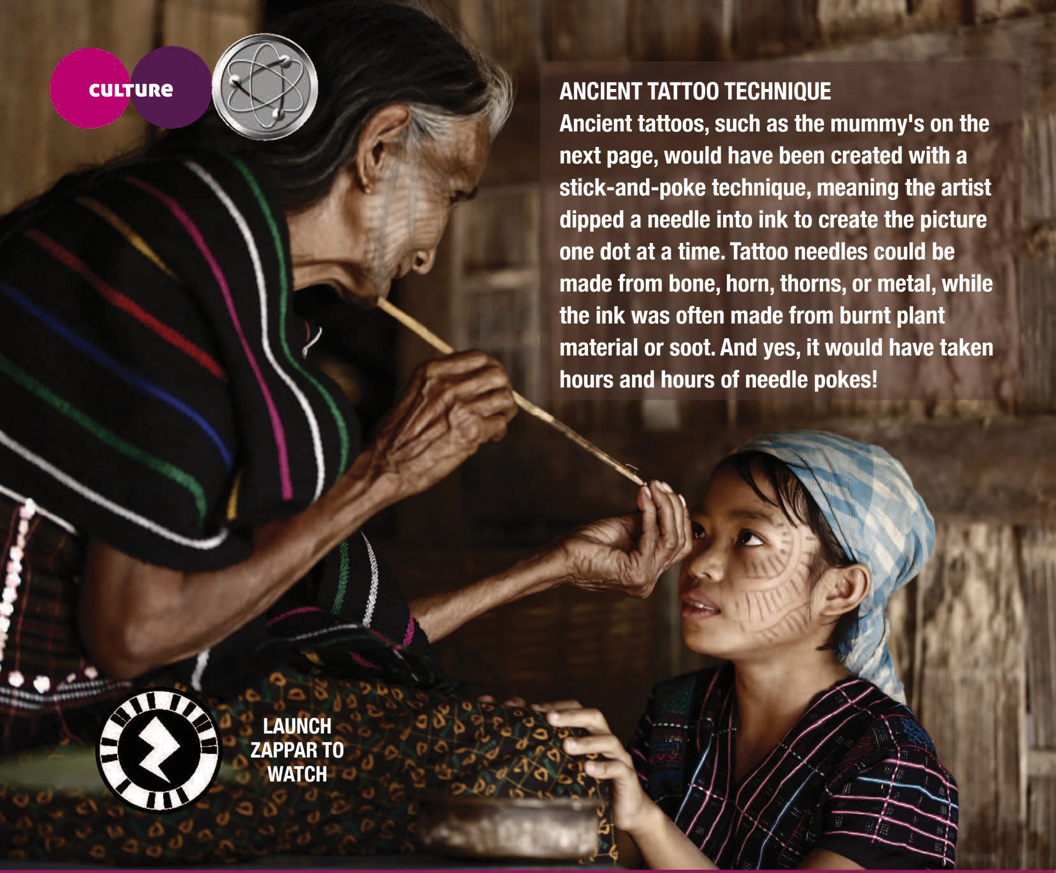


## Can other things produce phosphine?

Some scientists think phosphine gas could be created on Venus without bacteria. They tested volcano eruptions, lightning strikes and asteroid impacts. They mixed chemicals, heated them and compressed them. So far, these experiments have not produced phosphine gas, and on Earth, only bacteria are known to make it. But chemists are still exploring other theories to make phosphine without bacteria.

## Is there life on Venus?

Scientists are still figuring this out. In science, there has to be lots of evidence before a theory can be proven true. Detecting phosphine gas doesn't mean for sure there is life on Venus, but it is a very promising start. The next step is for Professor Greaves and other astronomers to keep gathering evidence and continue analyzing each spectrum carefully. Other astronomers are running computer simulations to see how phosphine gas could be created. Maybe someday, a mission to Venus could scoop up a sample from the clouds to find out, once and for all, whether bacteria are there.



**ANCIENT TATTOO TECHNIQUE**

Ancient tattoos, such as the mummy's on the next page, would have been created with a stick-and-poke technique, meaning the artist dipped a needle into ink to create the picture one dot at a time. Tattoo needles could be made from bone, horn, thorns, or metal, while the ink was often made from burnt plant material or soot. And yes, it would have taken hours and hours of needle pokes!

LAUNCH ZAPPAR TO WATCH

Fifty years ago, tattoos were rarely seen, and if you had one, people might have thought you were in a gang or had been in prison. Today, tattoos are a popular form of body art. But tattoos are not new. In fact, people have been tattooing themselves for over 5,000 years!

Many ancient cultures all over the world used tattoos. The Egyptians, the Māori in New Zealand, the Inuit, the Polynesians and the Japanese are just a few of the cultures with ancient tattooing traditions. What the tattoos meant is, in many cases, a mystery. They could reveal a person's status, role, family or social group; they might reflect religious beliefs or protection against evil; some were used for healing; and some could have been just for adornment.

# THE ANCIENT ART OF TATTOOS

BY HOLLY BENNETT

A lot of our knowledge of ancient tattoos comes from art and ancient writings, since preserved tattoos on human bodies are very rare. The other source? Mummies! Tattoos on mummified skin are generally invisible to the naked eye, but under near-infrared light they become visible.

PHOTO BY M. VAVULIN

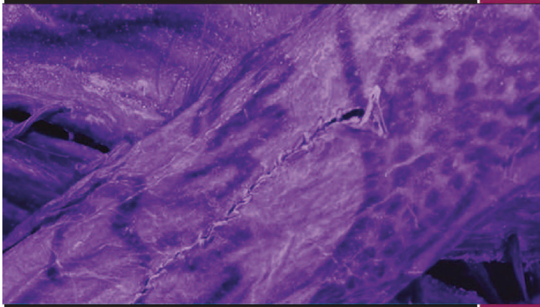
SPECIAL SOFTWARE WAS USED TO CREATE THIS 3-D MODEL USED FOR THE SCIENTIFIC STUDY OF ITS TATTOOS.

# Awesome tats!

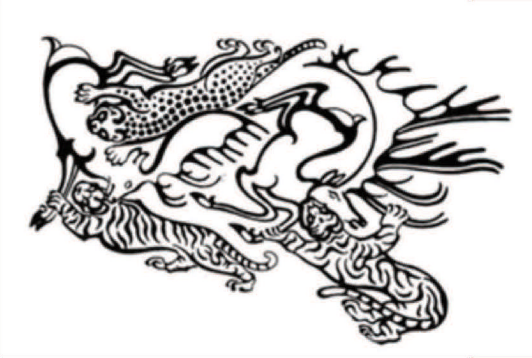
Ancient people didn't have today's electric tattooing tools, but they could still turn out highly skilled tattoos. A recent example is a 2,000-year-old mummy that was preserved in ice in Siberia. The 50-year-old woman has tattoos on each arm, and the one on the right forearm is so elaborate that even modern tattooists would find it a challenge!

Her tattoo shows 2 tigers and a leopard (complete with stripes and spots) intertwined with 2 stags. It flows along the muscle and would likely have looked really cool when she flexed her arm. Daniel Riday, a French tattoo artist who was interviewed on "*As it Happens*" on CBC radio, called it "a masterpiece" and "incredibly impressive."

The tattoo on the left arm (an animal with hooves being attacked by a griffin) is not as skilled. Experts think it was done by a different artist, or the same artist earlier in their career.



A CLOSE-UP SHOWING PART OF A TATTOO AS IT APPEARED UNDER NEAR-INFRARED LIGHT.



AN ARTIST'S DRAWING OF THE MOST ELABORATE TATTOO, SHOWING HOW IT WOULD HAVE LOOKED BEFORE BEING DAMAGED BY TIME AND MUMMIFICATION.

(THE PHOTOS ON THIS PAGE WERE SHARED BY THE SCIENTISTS WHO STUDIED THE MUMMY, AND WROTE ABOUT ITS TATTOOS IN THE OCTOBER 2025 ISSUE OF *ANTIQUITY*.)

# TEMPORARY TATTOOS

BY GABRIELLE MIDDLETON

## YOU WILL NEED

**BLANK PAPER, PENCIL, BLACK EYELINER PENCIL** (one that needs to be sharpened - not the liquid kind), **LIQUID BANDAGE, ALOE VERA GEL**

## METHOD

1. Grab a piece of paper and a pencil, and practice a few fun tattoo ideas. Keep drawing until you find the one you love the most!
2. Wash the spot where you'll put your tattoo with warm water and soap. Dry it completely with a towel.
3. Use a bold eyeliner pencil to carefully draw your design on your clean, dry skin. Messed up? No problem! Just wash it off and try again.
4. When you're happy with your design, spray a little liquid bandage over it to help it stay on for a few hours.
5. Ready for a new design? Wash your skin with soap and warm water or use Aloe Vera gel to remove the tattoo.

## ROLL A DIE. PLACE THE NUMBER IN A GRID. GOAL: TRY TO GET LIKE NUMBERS BESIDE EACH OTHER

EACH PLAYER GETS A GRID. FIRST PLAYER ROLLS A DIE. EACH PLACES THE NUMBER SOMEWHERE IN THEIR OWN GRID.

**Gabby**

| | | | | |
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| 5 | | | | |
| | | | | |
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**Kamil**

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**Kobe**

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NEXT PLAYER ROLLS THE DIE AND ALL PLAYERS PLACE THE NUMBER. REPEAT THIS UNTIL THE GRID IS FILLED.

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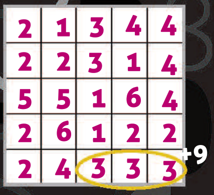
| 2 | 1 | 3 | 4 | 4 |
| 2 | 2 | 3 | 1 | 4 |
| 5 | 5 | 1 | 6 | 4 |
| 2 | 6 | 1 | 2 | 2 |
| 2 | 4 | 3 | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| 5 | 1 | 2 | 2 | 2 |
| 4 | 5 | 1 | 1 | 3 |
| 4 | 4 | 2 | 6 | 6 |
| 4 | 2 | 2 | 1 | 3 |
| 3 | 3 | 4 | 2 | 3 |

| | | | | |
|---|---|---|---|---|
| 4 | 5 | 3 | 3 | 3 |
| 2 | 5 | 3 | 2 | 3 |
| 1 | 6 | 2 | 2 | 2 |
| 1 | 1 | 4 | 6 | 2 |
| 1 | 4 | 4 | 4 | 2 |

TIME TO SCORE. LOOK FOR NUMBER NEIGHBOURS. ADD THEIR SUMS WHEN YOU FIND THEM.



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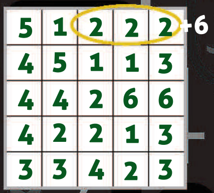

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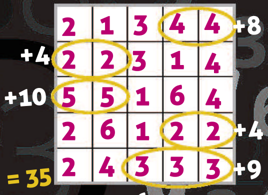
| 4 | 4 | 2 | 6 | 6 |
| 4 | 2 | 2 | 1 | 3 |
| 3 | 3 | 4 | 2 | 3 |

| | | | | |
|---|---|---|---|---|
| 4 | 5 | 3 | 3 | 3 |
| 2 | 5 | 3 | 2 | 3 |
| 1 | 6 | 2 | 2 | 2 |
| 1 | 1 | 4 | 6 | 2 |
| 1 | 4 | 4 | 4 | 2 |

CHECK EACH ROW HORIZONTALLY AND THEN VERTICALLY TO CIRCLE NUMBERS THAT ARE ALIKE.



| | | | | |
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| 2 | 1 | 3 | 4 | 4 |
| 2 | 2 | 3 | 1 | 4 |
| 5 | 5 | 1 | 6 | 4 |
| 2 | 6 | 1 | 2 | 2 |
| 2 | 4 | 3 | 3 | 3 |

| | | | | |
|---|---|---|---|---|
| 5 | 1 | 2 | 2 | 2 |
| 4 | 5 | 1 | 1 | 3 |
| 4 | 4 | 2 | 6 | 6 |
| 4 | 2 | 2 | 1 | 3 |
| 3 | 3 | 4 | 2 | 3 |

| | | | | |
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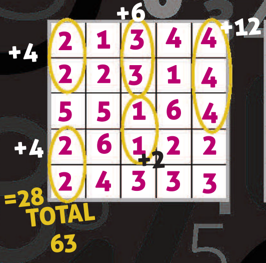
| 4 | 5 | 3 | 3 | 3 |
| 2 | 5 | 3 | 2 | 3 |
| 1 | 6 | 2 | 2 | 2 |
| 1 | 1 | 4 | 6 | 2 |
| 1 | 4 | 4 | 4 | 2 |

A NUMBER CAN BE COUNTED TWICE IF IT PAIRS WITH BOTH VERTICAL AND HORIZONTAL NEIGHBOURS.



| | | | | |
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| 5 | 1 | 2 | 2 | 2 |
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| 4 | 4 | 2 | 6 | 6 |
| 4 | 2 | 2 | 1 | 3 |
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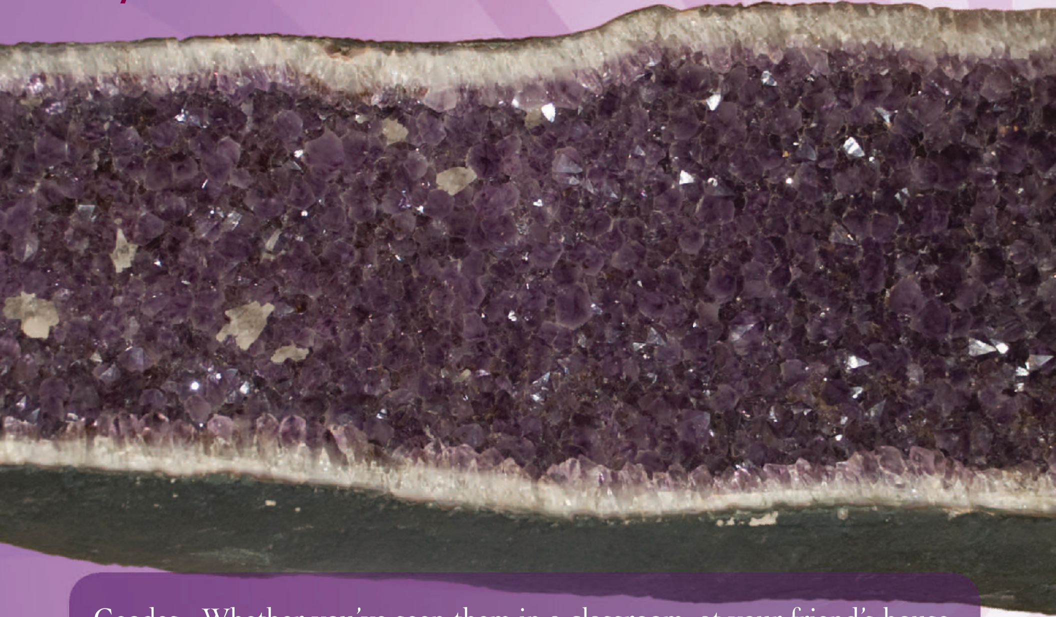
| 4 | 5 | 3 | 3 | 3 |
| 2 | 5 | 3 | 2 | 3 |
| 1 | 6 | 2 | 2 | 2 |
| 1 | 1 | 4 | 6 | 2 |
| 1 | 4 | 4 | 4 | 2 |

ADD THE TOTAL SCORE FOR YOUR GRID. HIGHEST SCORE WINS! PLAY AGAIN.

# LET'S PLAY
# *Number Neighbours*

# All That Glitters

by Alex Middleton



Geodes. Whether you've seen them in a classroom, at your friend's house, or you have one yourself, you've likely been dazzled by these rocks packed with colourful crystals inside. But what are they really?

Well, what most people don't know is that "geode" isn't the name of the rock itself, but the hollow void that the crystals form inside. This happens when a gas bubble is formed within volcanic rock. Over a long period of time, water (rich with minerals) will seep inside the rock, forming a lining of crystals within the bubble. This process can occur many times due to changes in temperature, creating the crystals within the rock.

There are many different types of crystals that can be found inside a geode. While most geodes contain clear quartz or amethyst (a purple crystal, the most common in geodes), there can be many other crystals found inside the rock. Geodes from the same locations will have similar crystals, although there is little to no way of finding out the type of crystal without breaking the rock open.

Now that we have a better understanding of what a geode is, and how it is formed, we can try to make our own version with crystals!

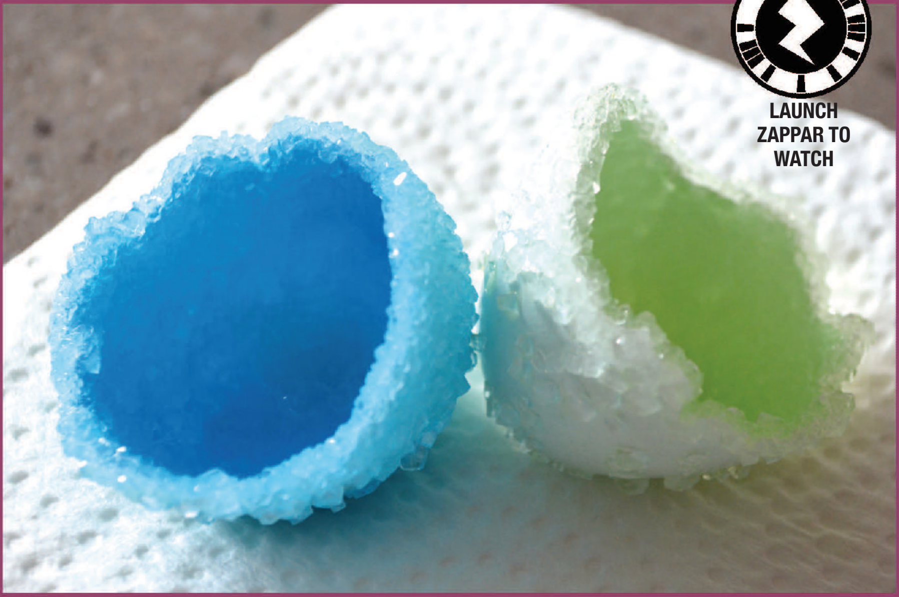
# Make A Crystal Eggshell

**You will need**

| | |
|---|---|
| 6 tbsps | Borax |
| 2 cups | Hot water |
| | Food colouring (optional) |
| 2 | Eggshell halves (cleaned) |
| 2 | Small heat-proof glass jars |
| 1 | tbsp measuring spoon |
| | Small spoon |

## Method

1. Fill each jar with hot water.
2. Add food colouring to each jar.
3. Mix 3 tbsps of Borax in each jar and stir well until diluted.
4. With a spoon, gently push each eggshell half into the water until it is fully submerged.
5. Set the geode in a location where it won't be disturbed. Allow 15 hours for the crystals to grow.
6. When you are pleased with the appearance of your eggshell, remove it from the solution and allow them to dry.



LAUNCH ZAPPAR TO WATCH

# Phoenician Phonics

### The Phoenicians never texted – but thanks to them, you can

by Carleigh Bodrug

Bill me for the glass, the fabric, the goats and...
Whoa, slow down. I'm chiselling as fast as I can!

**We often think of expressing our thoughts on paper (or smart phones) as something completely natural. It's hard to imagine a time when our ancestors didn't have a system for writing. The evolution of writing is one of the most important developments of humankind. It gives us the ability to preserve our ideas and stories over time. So who developed the code we call writing?**

**The first written language goes back at least 5,000 years to Mesopotamia (see next page). But our alphabet – and almost all alphabets* in the modern world – can be traced to the Phoenicians. They were skilled glassmakers, jewellers, textile makers, sculptors and traders who originally lived in the area we now call Lebanon in the Middle East, but sailed across the Mediterranean Sea and beyond, spreading their culture and ideas.**

**Editor's note: Asian languages use characters developed independently.*

## Spreading the word

The Phoenicians created a 22-letter alphabet that included only consonant sounds, not vowels. It was the first system of writing made up entirely of symbols that represent sounds—in other words, it was a phonetic alphabet. Earlier forms of writing used symbols to represent numbers, objects or ideas.

Such a small and simple alphabet allowed many people to learn to read and write. And during their wide travels, the Phoenicians spread their alphabet to other civilizations, such as the Greeks and Romans. The modern Hebrew, Arabic and English alphabets all owe a debt to the Phoenicians.

# From Mesopotamia...

The history of writing began over 5,000 years ago with cuneiform. The Sumerians, an ancient civilization in Mesopotamia (modern-day Iraq), used reeds to make wedge-shaped marks in soft clay tablets.

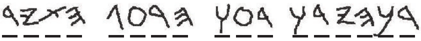
The earliest cuneiform script included hundreds of signs called "pictographs" that represented objects, not the sounds of words. Eventually this writing system was replaced by the Phoenician alphabet.

# ...to Egypt

The ancient Sumerian pictographs probably influenced the Egyptians, who developed their own system of writing called hieroglyphics around the same time. Hieroglyphics were a combination of pictographs and symbols that represented sounds (like the letters in our alphabet). The Egyptians carved them in stone or wrote them on papyrus, which was made from the stem of a water plant they unrolled and sun-dried to make an early form of paper.

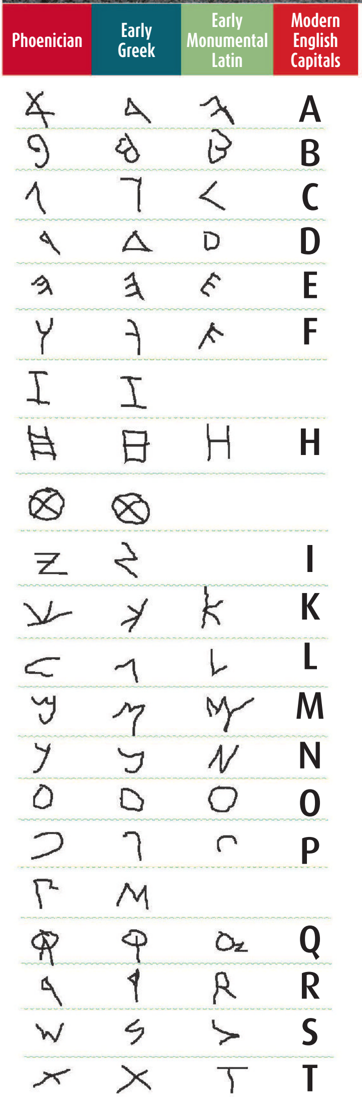
*Launch Zappar to watch*

**Watch the video below and use the symbol chart to decode the Phoenician message below:**



Go to brainspacemagazine.com to print a code sheet

# DECODE ANCIENT LANGUAGES


Phoenician
Early Greek
Early Monumental Latin
Modern English Capitals
A
B
C
D
E
F
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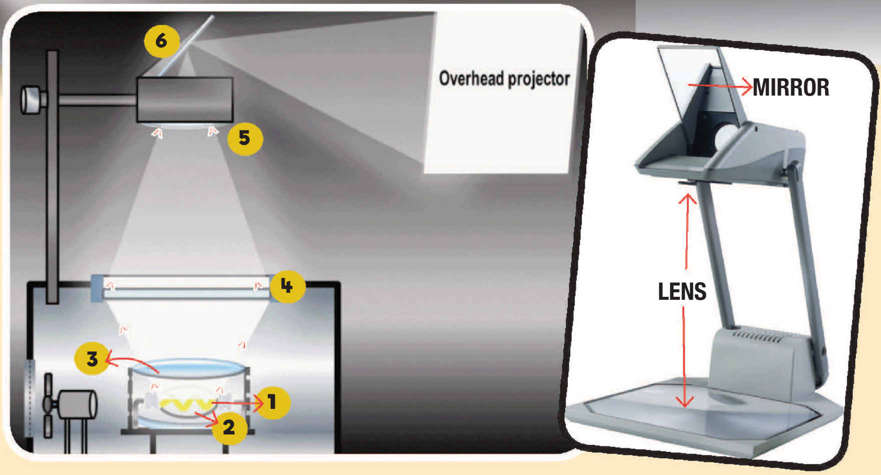
# Projectors

## HOW DO THEY WORK?



Overhead projectors use mirrors and lenses to redirect and focus light to project an image.

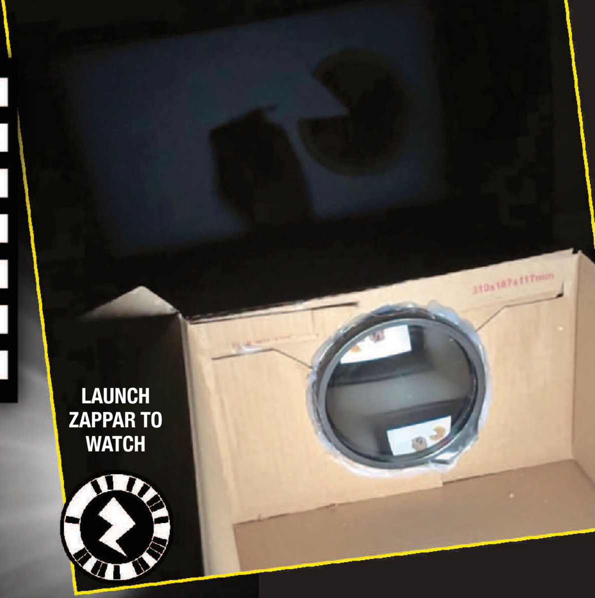
1. A light source at the base of the projector shines light.
2. This light is reflected upwards by a mirror under the light source.
3. The light passes through a convex lens, which is shaped like the back of a spoon.
4. The light continues to travel through another lens (called a Fresnel lens) which concentrates the light as it passes through the projector base and a thin transparent sheet that displays the text or images to be projected.

   The Fresnel lens focuses the light so that when it leaves the base the light will form a pyramid.

   Think of the pyramid holding the projected image with the edges of the image getting closer and closer together.
5. The pyramid of light will go through another lens in the projector's head. It then forms its peak in reverse, creating an upside-down image.
6. The image carried in the light gets bigger and bigger, but is upside-down. Finally, the upside-down image hits the second mirror, flipping it right-side up and changing its direction so that, rather than appearing on the ceiling, the image is displayed on the wall.

@RBALZAN79/ANALYSIS-OF-THE-OPTICAL-ELEMENTS-OF-AN-OVERHEAD-PROJECTOR

# DIY PROJECTOR



LAUNCH ZAPPAR TO WATCH

## YOU WILL NEED:

**MAGNIFYING GLASS, MOBILE DEVICE, SHOE BOX, FOAM BOARD, GLUE GUN, DOUBLE-SIDED TAPE, RULER, BOXCUTTER KNIFE, PENCIL**

## METHOD:

1. **Ask an adult to help remove the handle from the magnifying glass.**
2. **On the short side of the shoebox, use a pencil to trace around the magnifying lens.**
3. **Ask an adult to help cut out the circle you traced using the boxcutter knife. Then, cut a semi-circle in the side-flap of the lid so that it doesn't obstruct the lens when the box is closed.** *(watch Zappar for demo)*
4. **Place the magnifying lens in the hole and glue it securely in place.**
5. **Grab the foam board and a ruler. Measure the inside width of your shoebox and the height of the box. Our width was 11.4 cm (4.5 in), and our height was 17.8 cm (7 in). Cut two pieces of foam board using the same measurements.**
6. **Lay one piece flat. Then glue the second piece upright in the middle of the first, like a little sign board.**
7. **Stick double-sided tape to the back of your phone. Place it horizontally on the upright piece of foam board, with the screen facing the magnifying lens. Make sure it can slide back and forth freely in the box. Turn the display brightness all the way up!**
8. **In a dark room, point the front of your box at a blank wall. Look through the lens from the outside and gently slide your phone forward or backward on the foam board until the image looks clear (not blurry!).**
9. **Press play on a video (try a *Brainspace* video), and enjoy your DIY movie projector!**

### *Why is my video displaying upside down?*

The magnifying lens flips the image (it's called "inverting"). That's just how lenses work, they bend light! Rotate and lock your phone screen upside down before playing the video. That way, it projects right-side up on the wall.

## Imagine if a giraffe could save your life

Even weirder, imagine if giraffe poo could save your life. Sounds ridiculous, but researchers in England are working to make this come true.

Scientists at the University of Leicester have teamed up with two nearby zoos – West Midlands Safari Park and Dudley Zoo – to study their never-ending collections of poo from animals such as giraffes, tigers and elephants. Why? In hopes of finding new ways to treat bacterial infections.

Right now, if you have a condition caused by bacteria, such as an ear infection or strep throat, you may be given an antibiotic medication like penicillin. Unfortunately, antibiotics have been given to humans so often since they were introduced in the 1940s that they sometimes don't kill all the bad bacteria; some of the bacteria have evolved to become used to them, becoming what are called "superbugs." This is a really serious problem, as people aren't healing like they should be and might get super sick.

Bacterial "superbugs" beware!

# ZOO POO TO THE RESCUE

By Galadriel Watson

Bacteriophages, commonly known as "phages," could be an answer. Even smaller than bacteria, phages are viruses that prey on bacteria, infecting and destroying them. They thrive in places where bacteria lurk, like in soil, the ocean and even human and animal feces. Researchers around the world are investigating phages to figure out how they could be used instead of antibiotics, or alongside them, to keep people safe.

PHAGES ARE VIRUSES THAT PREY ON BACTERIA, INFECTING AND DESTROYING THEM

The challenge is that a specific phage can only harm a narrow range of bacteria – sometimes just one type. This means that researchers are trying to find all sorts of different phages to figure out which ones kill which bacteria – and what better place to find new ones than in exotic-animal poo!

Every day, zookeepers are scooping up the poo of over 160 species at Dudley Zoo and over 100 at West Midlands Safari Park, and are happy to hand over the results. The scientists at the University of Leicester are hoping to discover 10,000 new phages over 2 years of study. One day, these might be used to create new treatments for bacterial infections, for animals and humans alike.

### Here, have some of mine

**Phages aren't the only way poo is used to help treat illness. In a person's colon, for example, live both good microbes and bad. Sometimes, there are too few of the helpful microbes and too many harmful ones – this can happen when a person gets infected by the bacteria *Clostridioides difficile*. To bump up the numbers of the "good," the patient receives a solution made from the poo of a healthy donor, which introduces beneficial microbes back into their body.**

**LAUNCH ZAPPAR**
to watch a
**BRAINBOMB fact**

# The Tale of Walking Whales

BY PASCALE BIDER

Whales are truly some of planet Earth's most astounding creatures. Blue whales are the largest animals to ever have existed. Sperm whales have the biggest brain of any living animal. Narwhals can grow tusks up to 3 m (9.8 ft.) long! Together with dolphins and porpoises, whales make up the group *Cetacea*. Today, all cetaceans live in oceans or in freshwater rivers, but this has not always been the case. Millions of years ago, the ancestors of whales actually walked on land! Grab your snorkel, put on your flippers and let's take a deep dive into the history of whales.

## The proof is in the poo

**Untangling whale history is no easy feat, and scientists sometimes use unconventional methods to work out this puzzle. Researchers in Canada are trying to learn more about whale evolution... by studying their poo! They collect samples of whale poo they find floating on the Atlantic Ocean. Then, they can analyze their samples to find microbes inside. These microbes help them understand how the whale stomach works now, and also how it worked in the past. So far, the team has learned that although whales today eat mostly meat, their ancestors ate a lot more plants. Now that must be some stinky science!**

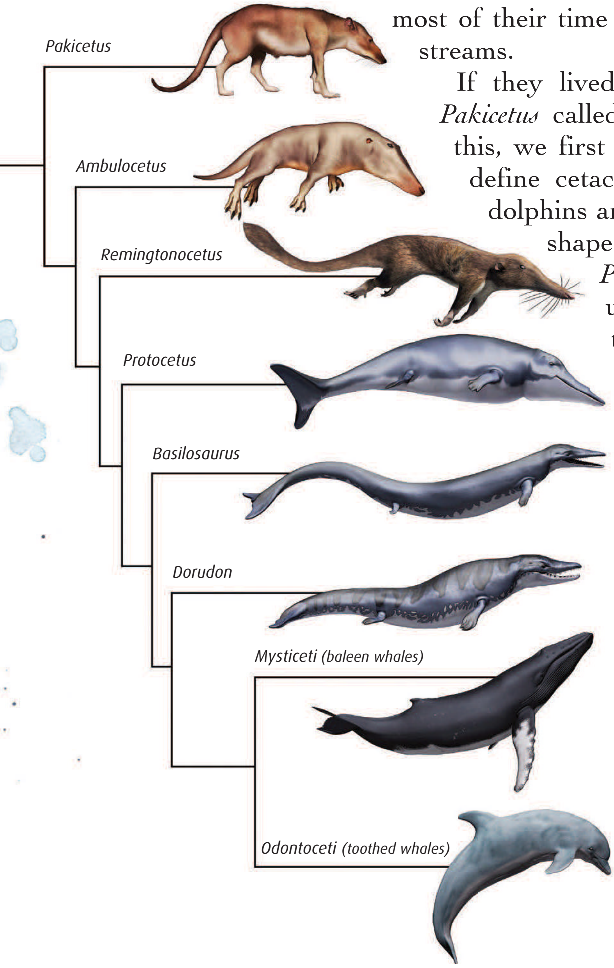
## Curious cousins

**By studying the whale family tree, scientists made an astounding discovery. They discovered that out of all animal species alive today, the one most closely related to whales is the hippo! Millions of years ago, whales and hippos shared a common ancestor, making these two species distantly connected cousins.**

# The first cetaceans

The oldest known cetacean was the *Pakicetus*. It lived in what is now Pakistan approximately 50 million years ago. Similar in size to a wolf, *Pakicetus* walked on four legs, and had a long snout and tail. Its eyes were close to the top of its head, like those of crocodiles today. By studying ancient *Pakicetus* bones and the rocks around them, scientists learned that these ancient animals once lived on land, but spent most of their time wading in shallow lakes and streams.

If they lived on land, why on earth is *Pakicetus* called a cetacean? To understand this, we first have to know how scientists define cetaceans in general. All whales, dolphins and porpoises have a distinctly shaped bone in their inner ear. *Pakicetus* skulls also share this unique feature, which makes them part of the group.



## Starting to swim

Over millions of years, the bodies of ancient cetaceans changed drastically as they became more aquatic. After *Pakicetus*, the ancestors of whales developed shorter limbs and flippers. For example, the ancient whale *Ambulocetus* had short legs and swam in rivers like a very large otter. Over time, cetaceans moved closer and closer to the ocean. The next whale ancestors, called *Remingtonocetus*, lived at the mouth of rivers along the ocean's coast. The *Basilosaurus* was among the first cetaceans to live entirely in salt water. They were also the first to develop the iconic whale tail that we know so well.

Today's whales, dolphins and porpoises spend their entire lives swimming in water. However, their skeletons show tell-tale signs of their terrestrial past. All cetaceans still have tiny bones in their tail where their ancestors' hind legs once were!

**LAUNCH ZAPPAR** to watch a **BRAINBOMB** fact

# PUFFIN PUZZLE

### THE MYSTERIOUS MIGRATORY PATTERNS OF THE PUFFIN HAD BIRD BIOLOGISTS BAFFLED – UNTIL NOW. BY BEN MAYCOCK

From May to August, the Atlantic puffin leads a bold and highly visible life. Summer breeding grounds, such as Machias Seal Island in the Bay of Fundy, attract tourists, naturalists and photographers who enjoy up-close and entertaining encounters with the "parrot of the sea." But as summer fades, the puffin disappears from land, a phenomenon that, until recently, has been a mystery.

Scientists have long puzzled over where puffins go during their winter migration. Now, thanks to advances in technology, they are able to get a more accurate picture of where these seabirds spend two-thirds of the year.

**Despite being more comfortable in the water than the air, puffins can still fly quite fast, flapping their wings about 400 times a minute and reaching speeds of about 80 km/h (49.7 mph)**

Satellite tags are one of the best ways to track migrating birds, but they can be expensive and weigh quite a bit. At roughly 20 cm (8 in) tall and weighing about the same as a can of soda, the puffin presents taggers with a particular challenge.

Heather Major, a seabird biologist at the University of New Brunswick, says they do not want to attach anything to a bird that weighs more than one percent of its body mass. Anything heavier than that impacts their ability to fly.

Luckily, advancements in tracking technology have allowed instruments such as geo-location tags to become smaller and lighter, while at the same time able to make more measurements and store more data.

And they can be just small enough to attach to a puffin without the animal being bothered by it.

In 2017, Major's UNB team attached 29 geo-location tags to puffins. The following year they were able to retrieve 21 of them. Each day the tags had recorded such data as light levels and water temperatures.

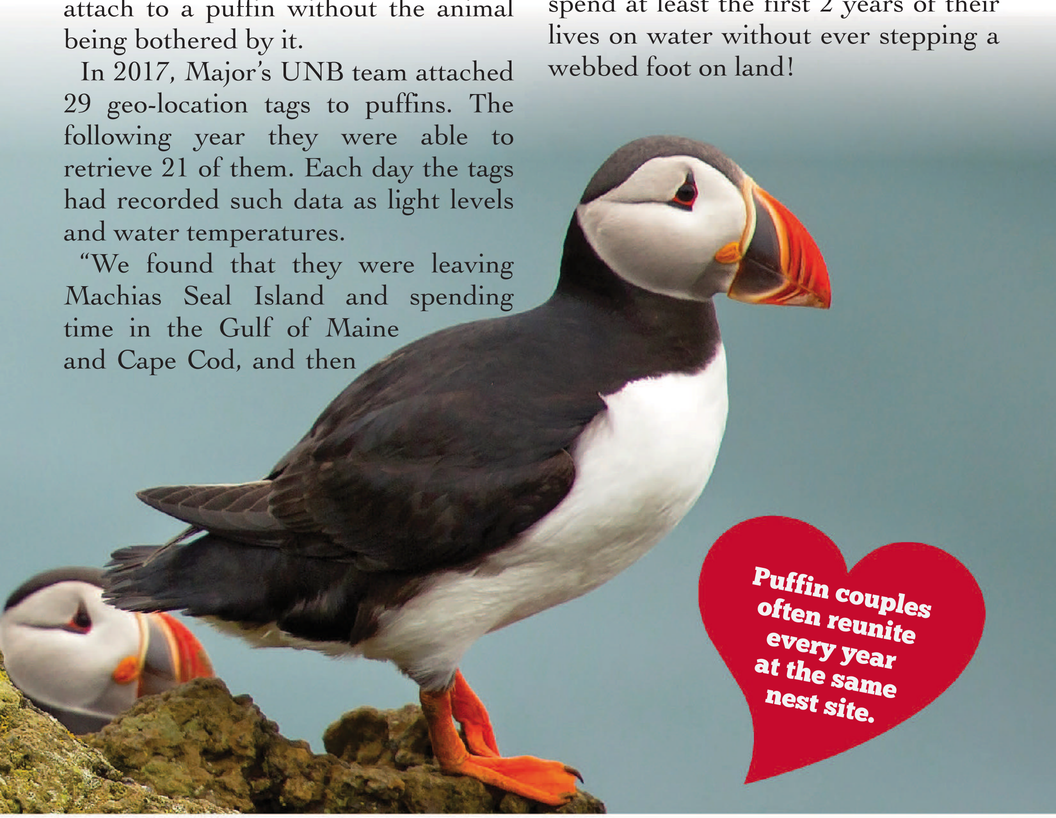
"We found that they were leaving Machias Seal Island and spending time in the Gulf of Maine and Cape Cod, and then going as far south as Cape Hatteras in the winter," says Major. "And then they start to make their way back up to the island in March."

## SO WHY HAD NO ONE SEEN THEM DURING THOSE WINTER MONTHS?

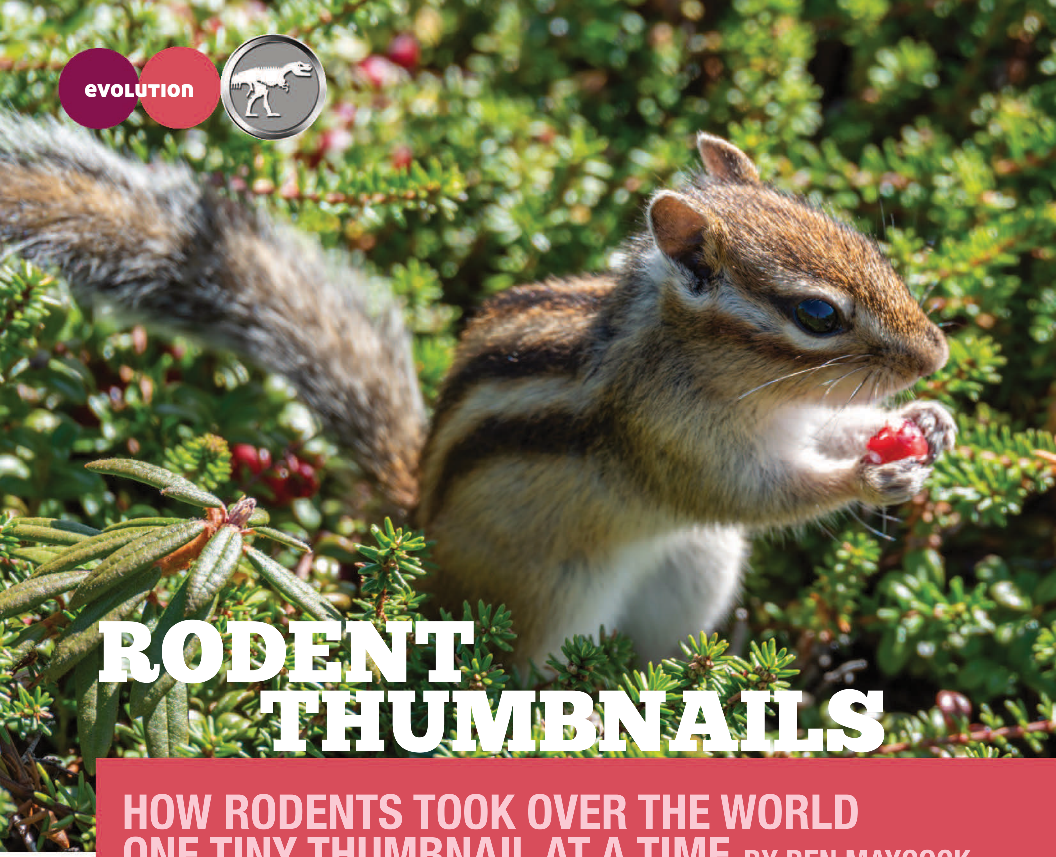
Surprisingly, the puffins were spending about 8 months of the year out on the open ocean, where they are perfectly at home.

Puffins are better swimmers than they are fliers, so it makes the most sense for them to stay close to their food source, using as little energy as possible to do so. When not feeding on schools of small fish, they rest and sleep on the waves. They can even drink salt water.

In fact, breeding is the only reason puffins leave the water. Young puffins spend at least the first 2 years of their lives on water without ever stepping a webbed foot on land!



Puffin couples often reunite every year at the same nest site.



# RODENT THUMBNAILS

## HOW RODENTS TOOK OVER THE WORLD ONE TINY THUMBNAIL AT A TIME

BY BEN MAYCOCK

Rodents are the undisputed champions of the mammal world. They make up about 40 percent of all mammal species and live on every continent except Antarctica. The secret to their success may come as a surprise!

According to a recently published study, part of the answer may lie in something surprisingly simple – thumbnails!

Similar to humans and most primates, many rodents have thumbnails like the ones on our hands. Their other fingers end in claws.

These thumbnail-equipped rodents are more likely to live in trees (arboreal) and use their forepaws to eat. Species without thumbnails, such as guinea pigs and capybaras, tend to live on the ground (fossorial) and rely more on their mouths to pick up food. These burrowing species need claws on all their finger-like digits for efficient digging.

**RESEARCHERS DISCOVERED THAT 86% OF RODENT GROUPS HAVE SPECIES WITH THUMBNAILS.**

**RESEARCH SUGGESTS THAT AROUND 50 MILLION YEARS AGO THE COMMON ANCESTOR OF ALL MODERN RODENTS PROBABLY HAD THUMBNAILS.**

Scientists believe that having a flat nail on their thumb gives rodents better manual dexterity, allowing them to grasp, handle, and eat tricky foods such as nuts, which require precision to open. This small advantage could have opened new food sources and new environments for early rodents.

This thumbnail trait appears to have independently evolved across the rodent family, suggesting it has been vital to its survival. This type of evolution is called convergent. Convergent evolution happens when organisms that aren't closely related evolve similar features, often within similar environments or as solutions to the same sorts of problems.

**Some species, such as naked mole rats, have a structure combining both a claw and thumbnail.**

Research also suggests that around 50 million years ago the common ancestor of all modern rodents probably had thumbnails. Fossils show that these early rodents had short, wide thumb bones, shaped more like those that support nails than claws.

What makes this really fascinating is that such a small part of the anatomy could have influenced a very big evolutionary shift. Thumbnails may have helped rodents crack into energy-rich foods such as nuts, resources that many other animals couldn't access. This may have given them an edge over other animals and allowed them to rapidly diversify and spread across the globe.

Rodent thumbnails turn out to be tiny tools of survival, proving that even the smallest things can have a huge impact.

CRAFT

# DIY
# SNOW GLOBE

BY GABRIELLE MIDDLETON

## YOU WILL NEED

**Mason jar or jar with lid, Water, Hot glue, Glitter and/or sequins, Small plastic or waterproof toys, Light corn syrup, Spoon**

LAUNCH
ZAPPAR TO WATCH

## WHAT DOES VISCOSITY MEAN?

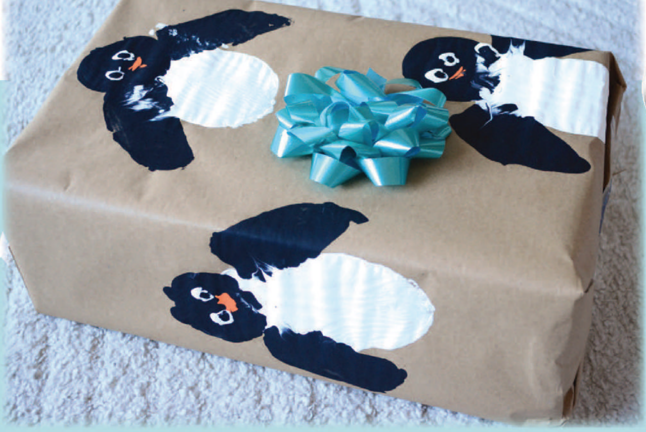
Viscosity is how thick a liquid is and how slowly it flows. For example, honey has high viscosity because it's thick and flows slowly, while water has low viscosity because it's thin and flows quickly.

## METHOD

1. Ask an adult to help you use hot glue to stick your plastic figurines to the inside of the jar lid. Make sure they're not too close to the edges, so the lid can still close tightly. Place the jar over the figurines to check before gluing.
2. Pour water into the jar until it's almost full. Add 2 tablespoons of light corn syrup and stir it in. Then add 1–2 tablespoons of glitter and/or sequins. Stir again to see how the glitter moves.
3. If it just floats to the top, add a little more corn syrup to help it swirl better.
4. Carefully screw the lid onto the jar to seal it tight.
5. Turn your jar upside down and watch the glitter swirl. Your snow globe is ready!

## HOW DOES LIGHT CORN SYRUP HELP MAKE THIS WORK?

When the snow globe is shaken, the glitter or sequins should float and swirl slowly, like falling snow. If only plain water is used, the glitter sinks too quickly. Adding a little light corn syrup to the water, makes the liquid thicker. This thickness is called viscosity. It's a way to describe how fast or slow a liquid flows. A liquid with higher viscosity moves more slowly than one with low viscosity. Adding corn syrup helps the glitter and sequins float and swirl more slowly, creating that magical snow globe effect!



LAUNCH ZAPPAR TO WATCH

# PENGUIN POTATO STAMP GIFT WRAP

BY GABRIELLE MIDDLETON

## YOU WILL NEED

**A kitchen knife, Paper towel, Acrylic paint (black, white, and orange), Paper plates or paint trays, Kraft paper roll (or paper large enough to wrap a gift), 1 large potato (or more if you want to create different shapes), Toothpick**

## METHOD

1. Ask an adult to help with the cutting. Carefully slice one end off the potato to create a flat surface – this will be used as the penguin's head. Cut a lengthwise slice from the potato for the body stamp. Then, cut the remaining piece in half to make two wings. Trim the wings if they seem too large. Finally, cut two small pieces: one for the beak and one for the eyes. Pat all pieces dry with a paper towel to help the paint stick better.
2. Roll out a large sheet of kraft paper (or any large paper) on a flat surface. This will be your custom gift wrap.
3. Pour each paint colour into its own tray or onto paper plates.
4. Let's stamp! Dip the body piece into white paint and press it firmly onto the paper.
5. Dip the head piece into black paint and stamp it just above the body.
6. Dip each wing piece into black paint and press one on each side of the body.
7. Dip the beak piece into orange paint and stamp it in the centre of the face.
8. Dip the eye piece into white paint and stamp on either side of the beak.
9. Finally, use a toothpick to dot the eyes with black paint. (Tip: the bigger the dot, the cuter your penguin!)
10. Repeat the stamping to create a fun pattern across the paper. Let everything dry completely.
11. Wrap your gifts with your adorable, handmade, one-of-a-kind penguin wrapping paper!

# 8 NEW YEAR TRADITIONS FROM AROUND THE GLOBE

### BY JAN KERTESZ

As December 31 approaches, many of us look forward to celebrating the arrival of the new calendar year with family and friends. Counting down the final seconds of the year and singing "Auld Lang Syne" are traditions familiar to us in North America.

Let's explore some other, perhaps lesser-known traditions from around the globe that you may want to include in your celebrations this year. (Spoiler alert: 2 of the traditions are messy, so it's probably best to skip those!)

## TASTY TREATS

**In Spain, eating grapes at midnight is believed to bring good luck in the upcoming year, according to a tradition that originated in the late 1800s. Can you guess how many grapes each reveller should eat to encourage prosperity and good fortune? It is customary to eat one grape each time the clock chimes at midnight. These 12 grapes also represent the number of months in the year.**

## SMASHING PLATES

In Denmark, the materials for December 31 festivities are gathered during the year leading up to the event. Danish revellers throw their chipped and unwanted dishware at the doors of friends and neighbours to bring the homeowners good luck and smash bad luck.

JANUARY
01
First Foot Day
02
BER
NUARY
08
JANUAR

## FIRST FOOTING

In Scotland, the first visitor to enter a home after the stroke of midnight is considered to be a very special guest. The person with the "first foot" through the front door ushers in good luck for the upcoming year by bringing gifts for the homeowner and their family. This tradition is believed to date back to the 8th century.

## CELEBRATING CIRCLES

In the Philippines, circular shapes are associated with coins and thought to symbolize prosperity. On December 31, 12 round fruits such as oranges, pomegranates, and melons are displayed on tables to encourage good fortune for the 12 months ahead. Wearing polka dots on the last day of the calendar year is also considered lucky in the Philippines.

## EMPTY SUITCASE

In many Latin American countries, including Colombia and Venezuela, some people walk around the block or their home with an empty suitcase at midnight. This ritual symbolizes their wish for a new year filled with travel and adventure.

## HANGING ONIONS

In Greece, onions are traditionally hung on the front door because they are considered symbols of personal growth and prosperity. Why onions? This vegetable sprouts and flourishes even when neglected.

## JUMPING WAVES

In Brazil, people head to the beach and jump 7 waves at midnight. The 7 waves represent the days of the week. When their jumps are completed, Brazilians don't turn their back to the water as this is considered bad luck. Instead, they walk backwards until they return to shore.

## SMASHING POMEGRANATES

In Turkey, homeowners smash a bunch of pomegranates or hang them on their front doors. The dozens of seeds within the fruit are said to symbolize abundance and wealth.

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